

THAT WHICH IS CLAIMED IS:

- 10017350.121401
1. A method of bonding two components, the method comprising:
positioning the components relative to one another to obtain a desired
5 orientation; and
bonding the two components in the desired orientation with metal
wherein a temperature of both components is maintained below a melting
temperature of the metal while bonding.
 - 10 2. A method according to Claim 1 wherein bonding comprises plating
the metal on the two positioned components.
 3. A method according to Claim 1 wherein bonding comprises
electroplating the metal on the two components.
 - 15 4. A method according to Claim 1 wherein bonding comprises
electroless plating the metal on the two components.
 5. A method according to Claim 1 wherein bonding comprises providing
20 an electrophoretic coating on the two components wherein the electrophoretic
coating comprises the metal and dielectric particles.
 6. A method according to Claim 1 wherein bonding comprises providing
particles of the metal on the two components and bonding the metal particles.
 - 25 7. A method according to Claim 6 wherein each of the particles of the
metal comprises a dielectric material coated with the metal.
 8. A method according to Claim 6 wherein bonding the metal particles
30 comprises allowing diffusion between the metal particles.
 9. A method according to Claim 8 wherein the metal comprises a metal
having a relatively high diffusion rate at room temperature.

10. A method according to Claim 9 wherein the metal comprises Indium.

5 11. A method according to Claim 8 wherein providing the particles of the metal comprises providing the particles of the metal with a dielectric coating thereon and wherein bonding the metal particles is preceded by rupturing the dielectric coatings.

10 12. A method according to Claim 11 wherein rupturing the dielectric coatings comprises passing an electric current through the particles.

15 13. A method according to Claim 8 wherein the metal comprises a first metal with a first rate of diffusion and wherein the particles comprise a coating of a second metal with a second rate of diffusion wherein the second rate of diffusion is lower than the first rate of diffusion.

14. A method according to Claim 13 wherein the first metal comprises Indium and the second material comprises Copper.

20 15. A method according to Claim 8 wherein providing the particles of the metal comprises providing the particles of the metal with a coating of a solid material that sublimates at a bonding temperature less than the melting temperature of the metal.

25 16. A method according to Claim 15 wherein the solid material comprises one of naphthalene or carbon dioxide.

30 17. A method according to Claim 8 wherein providing the particles of the metal comprises providing the particles of the metal with a diffusion barrier thereon and wherein bonding the metal particles is preceded by rupturing the diffusion barrier.

18. A method according to Claim 6 wherein providing the particles of the metal comprises vibrating the metal particles apart from the components,

and after positioning the components, applying the metal particles to the components.

19. A method according to Claim 6 wherein bonding the metal particles
5 comprises passing an electrical current through the metal particles sufficient to weld interfaces thereof.

20. A method according to Claim 6 wherein providing the particles
10 comprises providing the particles in a foam and wherein bonding the metal particles comprises collapsing the foam.

21. A method according to Claim 6 wherein bonding the metal particles
15 comprises introducing a liquid species that amalgamates with the particles at a bonding temperature less than the melting temperature of the metal.

22. A method according to Claim 21 wherein the metal comprises silver
and the liquid species comprises mercury.

23. A method according to Claim 6 wherein bonding the metal particles
20 comprises corroding the metal particles.

24. A method according to Claim 23 wherein corroding the metal
particles comprises oxidizing the metal particles.

25. A method according to Claim 24 wherein corroding the metal
25 particles comprises galvanically corroding the metal particles.

26. A method according to Claim 6 wherein bonding the metal particles
30 comprises applying pressure to the metal particles.

27. A method according to Claim 6 wherein bonding the metal particles
comprises plating a metal thereon.

28. A method according to Claim 6 wherein bonding the metal particles comprises providing a solution of a second metal on the metal particles to initiate a displacement reaction.

5 29. A method according to Claim 1 wherein positioning the components is preceded by:

providing particles of a metal on at least one of the components and vibrating the particles;

10 wherein positioning the components comprises positioning the components while vibrating the particles; and

wherein bonding the two components comprises ceasing vibrating the particles.

15 30. A method according to Claim 1 wherein a first one of the components comprises a substrate.

20 31. A method according to Claim 30 wherein a second one of the components comprises one of a micro-electronic component, a micro-optical component, or a micro-mechanical component.

32. A method according to Claim 30 wherein the substrate comprises one of a dam thereon or a well therein.

25 33. A method according to Claim 1 wherein a temperature of the metal is maintained below a melting temperature of the metal while bonding.

30 34. A metallically bonded structure comprising:
first and second components; and
a plurality of bonded metal particles providing bonding between the two components.

35. A structure according to Claim 34 wherein each of the metal particles comprises a dielectric material coated in the metal.

36. A structure according to Claim 34 wherein each of the bonded metal particles comprises a corroded layer thereon wherein the corroded layer of adjacent particles provides bonding therebetween.

5 37. A structure according to Claim 36 wherein the corroded layer comprises an oxide of the metal.

38. A structure according to Claim 36 wherein the corroded layer comprises a galvanically corroded layer.

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39. A structure according to Claim 34 wherein the first component comprises a substrate.

40. A structure according to Claim 39 wherein the second component
15 comprises one of a micro-electronic component, a micro-optical component, or a micro-mechanical component.

41. A structure according to Claim 34 wherein adjacent metal particles
20 are bonded at interfaces therebetween with voids remaining between metal particles.

42. A structure according to Claim 41 wherein adjacent metal particles
25 have a metal to metal contact at a bonding interface therebetween and wherein at least one of the metal particles comprises a dielectric layer on a portion thereof.

43. A structure according to Claim 34 wherein adjacent metal particles are bonded by layers of corrosion thereon.

30 44. A structure according to Claim 43 wherein the layers of corrosion comprise an oxide of the metal.

45. A structure according to Claim 43 where the layers of corrosion comprise galvanic corrosion.

46. A structure according to Claim 43 wherein the metal particles comprises a metal with high diffusion rate at room temperature.

5 47. A structure according to Claim 46 wherein the metal particles comprise indium.

48. A structure according to Claim 34 wherein the bonded metal particles comprises a first metal, the structure further comprising:

10 a plated layer comprising a second metal between bonded metal particles wherein the second metal and the first metal are different.

49. A metallically bonded structure comprising:
first and second components; and

15 a metal layer between the first and second components wherein the metal layer provides bonding between the two components and wherein the metal layer extends onto a portion of the second component opposite the first component.

20 50. A structure according to Claim 49 wherein the metal layer comprises a plurality of bonded metal particles.

51. A structure according to Claim 49 wherein the metal layer includes dielectric particles therein.

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52. A structure according to Claim 49 wherein the metal layer comprises an amalgam.

53. A structure according to Claim 52 wherein the amalgam comprises
30 silver and mercury.

54. A structure according to Claim 49 wherein the first component comprises a substrate.

55. A structure according to Claim 54 wherein the second component comprises one of a micro-electronic component, a micro-optical component, or a micro-mechanical component.

5 56. A micro-structure comprising:
a substrate;
a micro-component positioned relative to the substrate; and
a plurality of metal particles adjacent both the substrate and the micro-component.

10 57. A micro-structure according to Claim 56 wherein the metal particles are bonded to one another.

15 58. A micro-structure according to Claim 56 wherein at least one of the metal particles comprises a dielectric material surrounded by a metal layer.

59. A micro-structure according to Claim 56 wherein at least one of the metal particles comprises a diffusion barrier thereon.

20 60. A micro-structure according to Claim 59 wherein at least one of the metal particles comprises a first metal having a first diffusion rate and wherein the diffusion barrier comprises a surface layer of a second metal having a second diffusion rate wherein the first diffusion rate is higher than the second diffusion rate.

25 61. A micro-structure according to Claim 59 wherein the diffusion barrier comprises a dielectric layer on the metal particle.

30 62. A micro-structure according to Claim 61 wherein the diffusion barrier comprises an oxide layer.

63. A micro-structure according to Claim 59 wherein the diffusion barrier comprises a layer of a material that sublimates at room temperature.

64. A micro-structure according to Claim 63 wherein the material that sublimates at room temperature comprises one of carbon dioxide or naphthalene.

5 65. A micro-structure according to Claim 56 wherein the metal particles comprise a metal that forms an amalgam when exposed to a dissimilar liquid metal species at a temperature less than the melting temperature of the metal.

10 66. A micro-structure according to Claim 65 wherein the metal comprises silver.

15 67. A micro-structure according to Claim 56 wherein the micro-component comprises one of a micro-electronic component, a micro-optical component, and/or a micro-mechanical component.

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